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(71) Applicant *(for all designated States except US)*: FIBER DOES, INC. [US/US]; 1470 North 4th Street, San Jose, CA 95112 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: LEE, Song, San [US/US]; 3240 Greentree Way, San Jose, CA 95117 (US).

(74) Agent: YU, Samson, G.; Acip International, Inc., Suite 830, 1990 North California Boulevard, Walnut Creek, CA 94596 (US).

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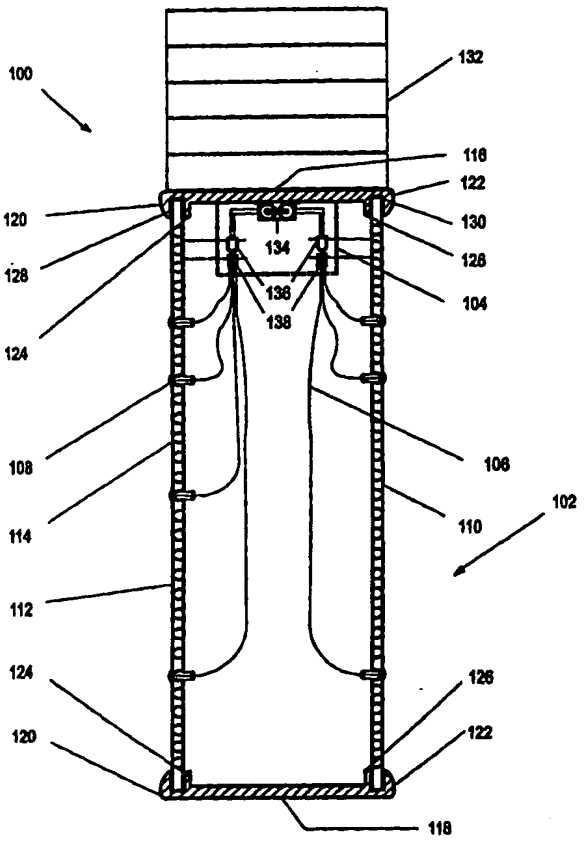
(57) Abstract

A fiber–optic sign (100) includes a housing (102), a light control circuit (104), a plurality of optic fibers (106) next to the light control circuit for transmitting light, a display panel (112, 500) of a plurality of apertures (114) for mounting optic fibers. To mount the optic fibers on the display panel, a plurality of couplers (108) made from acrylic material of dye additive are provided with each having at least a convex head, a body, and a first neck. The first neck is formed between the convex head (302) and the body (304) for providing a frictional coupling between couplers and apertures. The body has two longitudinal slots (312, 314) meeting at a right angle and a tapered hole (310). The slots split the body into four parts to resiliently hold an optic fiber in the tapered hole. A second neck (308) is formed next to the convex heat to allow for further resilient flexibility. The couplers may improve light–rendering effect of optic fibers and easily mount optic fibers in position. Moreover, the panel is formed of at least a flange side (518, 520) of a concavity (526, 528) and a receiving side (514, 516) of a projection (522, 524), so two or more panels may be joined to provide a large display area.



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FIBER-OPTIC SIGNS

TECHNICAL FIELD

The present invention relates to signs, in particular, to fiber-optic signs. A major objective of the present invention is to provide a fiber-optic sign that can uniformly render bright pattern or information.

BACKGROUND ART

Much modern technology is closely identified with the manufacturing and the applications of optical fibers. The critical feature of optical fibers is the transmission of light. When the light is traveling in an optical medium of refractive-index n_1, it strikes an interface with an optical medium of refractive-index n_2, then the total reflection will occur in case of n_1 larger than n_2 and an incident angle (measured to the normal of the interface) larger than a critical angle of total reflection. In such a fashion, light rays are repeatedly reflected within the optical medium of refractive-index n_1 in the direction of the transmission with little loss of light energy.

One of the applications of optical fibers is information display in which bare optical fibers are employed. Since an optical fiber possesses a refractive-index larger than that of air, light rays into one end of a bare optical fiber can be transmitted forward along the axis of the optical fiber and finally refracted into air at the other end of the optical fiber.

The use of such optical fibers allows light from a light source to be transmitted to remote and spaced locations where the light rays may be emitted as either a point or line of illumination. Because of this unique capability of light transmitting, optical fibers are used to create a variety of visual and ornamental displays.

U.S. Patent No. 4,917,448 to M. David Oppenheimer, "Oppenheimer" herein, disclosed a lighted display device that comprises a display panel having a plurality of lighting elements arranged in a pattern, one ends of a plurality of light conducting fibers are removably received within lighting element locations on the display panel. The other ends of the fibers are received and retained within a support member. Light from a light source is received by the other ends of the fibers and conducted to the one ends of the fibers for illumination of the display panel. A sleeve member engages each of the fibers for establishing a predetermined relationship between the portions of the fibers extending between the ends thereof to facilitate untangling of the fibers. In addition, a tip member is secured to the one end of each of the fibers for removably attaching the one end of each of the fibers to the display panel.

U.S. Patent No. 5,040,320 to Michael J. Reidinger, "Reidinger" herein, addressed an emergency illumination display assembly. It comprises a display board containing information, the ends of optical fibers of an fiber-optic bundle selectively positioned in the display board, and a source of electromagnetic radiation in the visible spectrum for directing into the other ends of the optical fibers of the fiber-optic bundle.

U.S. Patent No. 5,398,170 to Song S. Lee, "Lee" herein, referred to an optical display apparatus that includes a plurality of optical elements of acrylic material and an additive. In particular, an optical element is used to mount each of optic fiber on the display panel. This optical element has a convex head and a cylindrical body with a dent at its tail end to hold the optic fiber. To keep the optic elements on the display panel, a clear transparent plastic plate has to be provided to sandwich the convex head between the display panel and the transparent plastic plate.

U.S. Patent No. 5,573,328 to Steven Hwang, "Hwang" herein, taught a house number light box that comprises a housing covered with a transparent covering to hold a house number panel and a control circuit on the inside and a solar cell on the outside. The control circuit is composed of a battery, a switch circuit, an oscillatory circuit, and a light source. The house number panel comprises a front side bearing a house number, a plurality of through holes arranged along the border of the house number, and a back side fixed with a holder to hold a number of fiber-optic tubes. Each fiber-optic tube has one end fastened to one through hole on the house number panel and an opposite end abutted to the light source for transmitting the light of the light source to the house number.

Since a single optic fiber is about 0.028 inch in diameter, the light emitted from its one end is only a little point which intensity is far from sufficiency. Therefore, in the prior art that acknowledged variety of fiber-optic displays, a fiber-optic bundle has to be used to provide sufficient light intensity for information or pattern display. However, such a solution to improve intensity suffers from a defect that all the tiny optical fibers of diameter of about 0.028 inch have to be arranged in order and fastened one by one on the display board, which is time-consuming and heavy workload in assembling. In addition, securing each single tiny optical fiber in position involves in labor cost and consequently, the maintenance can be complicated with high costs. As a result, the prior art is hard to be commercialized since its assembling and maintenance results in high costs customers can not afford.

To facilitate the assembling, prior art suggested elements for retaining the optic fibers in position. However, these elements either did nothing help with or even weaken light-emitting capability of optic fibers, or required other parts assistant to keep them in position and to hold optic fibers. In addition, no prior art can provide custom-designed signs of an adjustable display area. Furthermore, prior art did not relate to a fiber-optic sign that can be visible in all-weather visible condition.

What is needed is a fiber-optic sign that can render an all-weather visible, uniform and bright information presentation with easy assembling and low costs.

In particular, a plurality of couplers of unique design can improve the intensity of light rays rendered from each single optical fiber and resiliently retain them. Each display panel is designed to be easily coupled with the other one to form an adjustable display panel. Also, a paint is applied to the display panel so that the fiber-optic signs in accordance with the present invention is visible in day time without the light source turned on.

DISCLOSURE OF INVENTION

In accordance with the present invention, a fiber-optic sign includes a housing and a light control circuit. A plurality of optic fibers are next to the light control circuit for transmitting light. A display panel of a plurality of apertures is provided for mounting the optic fibers. To retain the optic fibers on the display panel, a plurality of couplers are employed with each having a convex head and a body. Preferably, the body has a first neck formed next to the convex head for providing a frictional engagement of each coupler and each aperture. The body may be cylindrical in shape. Preferably, the body is tapered in shape so as to form a stopper next to the first neck to prevent the fiber-optic coupler from out off the aperture after it fits into the aperture. Alternatively, the cylindrical body may have a stopper projected from the body.

The body has at least one first longitudinal slot and a longitudinal hole to resiliently hold an optic fiber. The longitudinal hole runs through the body and the first neck for accommodating the optic fiber. Preferably, the body has a second slot. The first and second longitudinal slots meet at a right angle and run through the body and at least part of the first neck, so the body of the coupler is divided as four parts that resiliently retain the optic fiber when it is forcibly inserted into the hole. Alternatively, a second neck may be formed between the first neck and the convex head to allow the four parts for further flexibility to resiliently hold the optic fiber.

The head of the fiber-optic coupler shapes like a convex since in accordance with the optics theory, the convex head helps light to be uniformly and maximally emitted. Also, the convex head of the coupler increases the light-rendering diameter of the optic fiber, so the visible effect of the optic fiber is improved. To provide information presentation of high resolution, a gap between each aperture is defined within a range of 0.2-1.5 inch. As a result, fewer optic fibers can be used to provide a continuous information presentation without a significant discrete visible effect while cutting the workload in assembling.

In addition, the diameter of the first neck is substantially same as that of each aperture so that the coupler in accordance with the present invention is frictionally engaged to the aperture. In accordance with the present invention, the convex head is designed larger than the first neck in diameter to retain the coupler in position and uniformly and maximally render light transmitted from the optic fiber, the stopper has a diameter larger than the first neck to hold the coupler in position once it fits into the corresponding aperture, and the first neck larger than the second neck in diameter to allow the body for further flexibility to resiliently hold an optic fiber. The first neck of the coupler has a height slightly lower than or substantially same as that of the second neck.

Preferably, the longitudinal hole in accordance with the present invention is tapered in shape with a first end contacting with the convex head and a second end in which the first end is larger than the second end in diameter. The first end is designed slightly larger than the optic fiber in diameter and the second end is slightly smaller than the optic fiber in diameter. As a result, the optic fiber can be appropriately mounted on the display panel while its light rendering effects are significantly improved by way of the coupler in accordance with the present invention. Consequently, the coupler in accordance with the present invention can resiliently hold the optic fiber and be firmly engaged to the aperture while uniformly and maximally rendering light from the optic fiber.

Preferably, each aperture on the display panel has an aperture neck and an aperture body. The aperture neck frictionally engages to the first neck of the coupler and the aperture body accommodates the body of the coupler.

In accordance with a preferred embodiment of the present invention, the display panel has a first side of a pair of flanges and a second side of a projection. The pair of flanges define a channel. With the assistance of the channel and projection, two or more display panels in accordance with the present invention may easily join together with the precision location by the engagement of the projection and channel. Therefore, to construct a fiber-optic sign of larger display area, it simply needs to join two or more display panels together. In addition, the apertures may be covered by a plurality of removable masks. The removable masks may be taken off with the couplers being inserted into them. This design provides customers with much flexibility to customize a pattern as desired. After a pattern is determined by customers, the masks are removed with the couplers being inserted into the masked apertures that define the pattern.

To improve the light rendering effects, the couplers in accordance with the present invention are made of transparent plastic materials. Preferably, the transparent plastic materials include acrylic material. Preferably, the acrylic material has a diffusion dye additive in it to help the convex head uniformly render the light from the optic fibers.

Furthermore, the light control circuit includes a rechargeable battery, preferably, a nickel-cadmium battery, and at least one light-emitting diode. The nickel-cadmium battery converts energy collected by a solar panel into electrical and store it to supply power to the light-emitting diode as needed. Preferably, a detect circuitry sensors light around the fiber-optic sign and when it is darker than a predetermined threshold, activates the nickel-cadmium battery to turn the light-emitting diode on.

To display information or a pattern in day time, a paint may be applied to the areas that defines information or pattern to be presented. Therefore, the fiber-optic signs in accordance with the present invention can be visible under all-weather condition. The paint that may be applied to the areas preferably includes vinyl, silkscreen, and enamel.

In accordance with the preferred embodiment of the present invention, the housing may be taken any of a number configurations, such as circular, oval, or muti-sided configurations may be utilized as desired. The present invention provides a fiber-optic sign of adjustable display area and bright light with low costs and simple assembling. In particular, the display panel of the fiber-optic signs has an angle from 0°-15° relative to the surface of the display panel so that the optic fibers on the display panel align with people's sign to provide good visible effects. These and other features and advantages of the present invention are apparent from the description below with reference to the following drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIGURE 1 is an illustrational view of a preferred embodiment of the fiber-optic sign in accordance with the present invention;

FIGURE 2 is block diagrams of the light control circuit in accordance with the present invention;

FIGURE 3 is an illustrational view of a preferred embodiment of the fiber-optic coupler in accordance with the present invention;

FIGURE 4 is a back view along line A-A of the fiber-optic coupler of FIG. 3 showing its construction;

FIGURE 5 is an illustrational view of a preferred embodiment of the display panel in accordance with the present invention;

FIGURE 6 is an enlarged view of a part of the display panel of FIG. 5;

FIGURE 7 is a cross-sectional view taken along line B-B of the display panel of FIG. 5 showing its constructional details;

FIGURE 8 is a perspective view of the fiber-optic sign in accordance with one preferred embodiment of the present invention;

FIGURE 9 is a cross-sectional view taken along line C-C of the fiber-optic sign of FIG. 8 showing its constructional details; and

FIGURE 10 is a perspective view of another fiber-optic sign formed with three display panels of FIG. 5 in which the display panels are of a plurality masked apertures.

BEST MODES FOR CARRYING OUT THE INVENTION

A fiber-optic sign **100** in accordance with the present invention includes a housing **102**, a light control circuit **104**, a plurality of optic fibers **106**, and a plurality of fiber-optic couplers **108**, as shown in FIG. 1.

It is envisioned that housing **102** may be taken any of a number configurations. As shown in the drawings, housing **102** is generally rectangular in shape. However, circular, oval, or muti-sided configurations may be utilized as desired. In particular, the housing **102** may be formed of plastic materials by plastic molding process or metal materials of good heat-conductive property, such as aluminum or steel.

In the preferred embodiments of the present invention, the housing **102** includes a front display panel **110** and a rear display panel **112** of a plurality of apertures **114**, a top section **116**, and a bottom section **118**. Both top section **116** and bottom section **118** are generally formed with similar cross section and include a generally planar outer wall integrated and formed with a pair of outer flanges **120** and **122**. The flange **120** is resilient and utilized to compress the display panels **110** and **112** against inwardly formed generally linear flange **124** and **126**. The linear flanges **124** and **126** are spaced relative to the outer flanges **120** and **122** respectively in order to provide elongated channels **128** and **130** in which the edge portions of the panel members **110** and **112** may be selectively and slidingly received.

Within the housing **102** is a light control circuit **104**, which typically includes a solar panel **132**, a battery **134** for storing the energy collected by the solar panel **132**, light-emitting diodes **136** that is connected to the battery **134**, and a fiber-optic bundle holder **138**.

With one ends next to the light-emitting diodes **136** and the other ends extended through the apertures **114** by means of fiber-optic couplers **108**, the optic fibers **106** receive light from the light-emitting diodes **136**, transmit it to the other ends, and emits it to the air from the fiber-optic couplers **108**. Consequently, a picture, design, or information that is patterned with the apertures **114** becomes visible. In accordance with the preferred

embodiments of the present invention, the optic fibers are commercially available from Mitsubishi Co. Although in the preferred embodiment, the light control circuit **104** is located inside of the housing **102**, it may also be located outside of the housing **102** with one ends of the optic fibers **106** next to it. Preferably, a fiber-optic bundle for receipt of light from each light-emitting diode is of 50 optic fibers, to provide uniform light intensity in each single optic fiber.

Block diagrams **200** of the light control circuit **104** are shown in FIG. 2, which include a solar panel **202**, a rechargeable battery **204**, a voltage control circuit **206**, light-emitting diode **208**, and a photo sensor **201**. The solar panel **202** collects the energy from sun so as to charge the rechargeable battery **204**. Voltage circuit **206** is a rectifier to adjust the voltage of the rechargeable battery **204** to keep it at a stable level. The photo sensor **201** connected to one input of the voltage circuit **206** detects the light around the fiber-optic sign in accordance with the present invention and when it is darker than a predetermined threshold, photo sensor **201** is on so that the power supplied to light-emitting diode **208** is switched on, thereby activating the light-emitting diode **208** to light the optic fibers next to it.

As a preferred embodiment, the fiber-optic coupler **108** in accordance with the present invention is shown in FIG. 3, which is made from transparent plastic material, preferably acrylic. To improve light-rendering effects, the acrylic material is mixed with a diffusion dye to change its optics property. Preferably, the fiber-optic coupler **108** has a convex head **302**, a body **304**, a first neck **306**, and a second neck **308**. At the center of the body **304** is a hole **310** that runs through the body **304**, the first neck **306**, and the second neck **308**. The hole **310** may be cylindrical in shape. Preferably, it is tapered in shape with its diameter bigger as it is closer to the convex head **302**. Two longitudinal slots **312** and **314** extend through the body **304** and stop at the end of the first neck **306**. The two longitudinal slots **312** and **314** meet at a right angle to split the body of the fiber-optic coupler into four parts, as shown in FIG. 4. Although it is shown in the preferred embodiment in accordance with the present invention as tapered in shape, the body **304** may be cylindrical in shape.

During the assembling, each fiber-optic coupler **108** is first inserted into each aperture **114**, and then, each single optic fiber is inserted into the tapered hole **310**. To firmly retain each optic fiber **106** in position, it has to first mount the fiber-optic coupler **108** on the display panel **112**. To facilitate to do it, a transition portion **316** is formed at the end of the fiber-optic coupler **108**. On the other hand, to prevent the fiber-optic coupler **108** from out off the aperture **114**, stopper **318** is formed next to the first neck **306** to retain the fiber-optic coupler **108** in position. . The convex head **302** and stopper **318** are larger than first neck **306** in diameter. Since the first neck **306** is frictionally engaged to the aperture **114** of the display panel **112**, the fiber-optic coupler **108** may be assured to be secured by the space defined with both convex head **302** and stopper **318**.

While the above preferred embodiments show a frictional engagement by the fiber-optic coupler **108** and the aperture **114**, many other couplings are available. For example, only a first neck is formed on the body and next to the convex head to provide fastened coupling; also, screw coupling, cap coupling, or bonding can be applied to engage the fiber-optic couplers to the apertures. Alternatively, with only one longitudinal slot and no first and second necks, the coupler in accordance with the present invention may still frictional engage to the aperture by its body and resiliently hold the optic fiber by the one longitudinal slot and the longitudinal hole.

In accordance with the preferred embodiment of the present invention, the design of the fiber-optic coupler **108** is to allow each single optic fiber not only to be easily inserted, but also to be firmly held. Accordingly, two longitudinal slots **312** and **314** are formed to allow the body **304** to resiliently hold each optic fiber, as shown in FIG. 4. Furthermore, the formation of the second neck **308** allows the body **304** for further flexibility to provide resilient holding of the optic fiber **106**. For the convenience of inserting the optic fiber **106** into the tapered hole **310**, a tapered portion **320** is formed at the end of the body **304**. To firmly hold the optic fiber **106**, the tapered hole **310** has its diameter slightly smaller than that of the optic fiber **106** at the end of body **304**, but slightly larger than or the same as that of the optic fiber **106** at the end of the second neck **308**.

In accordance with one preferred embodiment, the diameter of the convex head **302** is about 0.200 inch; the diameter of the body **304** is about 0.140 inch; the diameter of the first neck **306** is about 0.146 inch for fitting into the aperture **114** of the diameter of about 0.150 inch; the diameter of the second neck **308** is about 0.125 inch; the tapered hole **310** to hold the optic fiber **106** of the diameter of about 0.028 inch has a diameter of about 0.030 inch at the biggest end and a diameter of about 0.021 inch at the smallest end; each of slots **312** and **314** is about 0.015 inch in width; the stopper **318** has a diameter of about 0.162 inch at its biggest end and a diameter of about 0.146 inch at its smallest end.

FIG. 4 is a back view along line A-A of the fiber-optic coupler **108** of FIG. 3 to show its construction. From FIG. 4, it can be seen that the slots **312** and **314** meet at the right angle and extend the cross section of the fiber-optic coupler **108** to divide the body **304** into four parts to resiliently hold the optic fiber **106** inserted into the tapered hole **310**.

In accordance with the present invention, a display panel **500** is preferably made by plastic molding process and is square in shape, as shown in FIG. 5. It has a body portion **512** on which a plurality of apertures **114** are formed, and four sides **514**, **516**, **518**, and **520**. The left side **514** is a pair of flanges extending outwardly from the body portion **512**, and the top side **516** has the similar construction as left side **514**; the right side **518** and the bottom side **520** project from the body portion **512**, as shown in FIG. 7. At the center of each of

the left side **514** and the top side **516** is of a location projection **522** or **524**. Correspondingly, at the center of each of the right side **518** and the bottom side **520** is of a location concavity **526** or **528**. Accordingly, two or more display panels **500** can be combined to provide a larger and adjustable display area.

An enlarged view of a part of the display panel **500** is shown in FIG. 6 in which two kinds of apertures are shown. One is masked aperture **602** that has an aperture mask **606** of four tabs **610** connected to the body portion **512** of the display panel **500**. Another one is aperture **604**. Depending on the requirements, the display panel **500** may be of only apertures **602** or **604**, but not both. For example, in case that users are not for sure what the pattern or information to be presented is exactly to be or they like to design a pattern by themselves, the display panel of masked apertures **602** may be chose. Otherwise, the display panel of apertures **604** may be used. With the mask **606** left, users may design any pattern or information to be presented on the display panel **500**, and by taking off masks **606** with the insertion of the fiber-optic couplers **108**, the pattern or information defined by those apertures is displayed with the optic fibers **106**. It allows users for much flexibility to display the patterns or information they desire to present, thereby making a sign with capability of customer design. Usually, the display panel of masked apertures is made by plastic molding process and used for custom design, so users may combine two or more square display panel together to form a shape as required, but the display panel made by metal is a integrated sheet that has been constructed by manufactures before delivering to users.

A cross-sectional view taken along line B-B of the display panel **500** of FIG. 5 is shown in FIG. 7. The display panel **500** of apertures **702** is made from plastic, preferably acrylic material, by plastic molding process. Each aperture **702** has an aperture neck **704** to engage to the first neck of the fiber-optic coupler **306**. An aperture body **706** is formed next to the aperture neck **704** for accommodating the body **304** and stopper **318**, thereby retaining the optic fiber **106** in position. Also shown in FIG. 7 is an illustration after the fiber-optic coupler **708** fits into the aperture **710**. The height of the aperture body **706** is preferably about 0.140 inch and the height of the aperture neck **704** is about 0.060 inch. The left side **514** is of a pair of flanges **714** that define a channel **712** and the right side **518** is a projection. The thickness of projection **518** matches with that of the channel **712** so that the projection **518** may closely fit into the channel **712**. The distance between two apertures is about 0.400 inch.

Rectangle fiber-optic sign **800** is a street sign in which apertures defining the information "FIRST ST" are formed on the display panel **802**. A solar panel **808** and a photo sensor **810** are mounted on the fiber-optic sign **800**. In this case, the display panel **802** is made from metal material, preferably aluminum. To display information or a pattern

in day time, a paint may be applied to the areas **804** defined by those apertures **806** so that the information or pattern to be presented can be visible without the light control circuit turned on. Therefore, the fiber-optic signs in accordance with the present invention can be used even in day time. The paint that may be applied to the areas **804** preferably includes vinyl, silkscreen, and enamel.

FIGURE 9 is a cross-sectional view taken along line C-C of the display panel **802** of FIG. 8. To keep panel members **902** and **904** in position, four plastic U rings **906**, **908**, **910**, and **912** are applied to the top and bottom edges of the panel members so as to have them filled in the channels defined by each pair of flanges **914** and **916**.

Alternatively, the display panel of masked apertures is formed by plastic molding process, as shown in FIG. 10. Similar to FIG. 8, a solar panel **908** and a photo sensor **910** are mounted on the fiber-optic sign. Users may design any pattern or information they like to present with removing masks from the masked apertures **902**. For example, "FIRST ST" may be presented with the apertures **902** defining these characters inserted by fiber-optic couplers. Since a few square display panels shown in FIG. 5 may be combined to provide a big display area, users can decide what pattern or information is to be presented. In this case, the display panel is constructed by combining three square display panels shown in FIG. 5 that are made from plastic material, preferably acrylic, by plastic molding process. Consequently, users enjoy the flexibility for customer design. Therefore, this flexibility plus the adjustable display area brings the fiber-optic signs in accordance with the present invention to a variety of applications.

The fiber-optic sign shown in FIG. 9 is similar to that shown in FIG. 1 in construction or configuration; the only difference between them is the display panel member. The one shown in FIG. 1 is made from plastic materials by plastic molding process and is constructed with the assembling three square display panels as shown in FIG. 5, but the one shown in FIG. 9 is made from one integrated metal sheet, such as aluminum sheet.

Preferably, the fiber-optic signs in accordance with the present invention can be applied for street signs and high-way signs. The existing street signs are not lighted so that they are hard to be read after dark by drivers and pedestrian who are not familiar with the area. While the exist high-way signs are lighted, power lines are indispensable, which brings up costs for building a high-way and also, have the potential dangerous for people and property. Use of the fiber-optic signs in accordance with the present invention, no power lines are required, which drops the building costs with the eliminating of the dangerous usually caused by power lines and saving energy. In accordance with one preferred embodiment of the present invention, the display panel of the fiber-optic signs has an angle from 0°-15° relative to the surface of the display panel so that the optic fibers on the display panel align with people's sign, thereby providing preferred visible effects.

It will be understood that the previous descriptions and explanations are given by way of example, and that numerous changes in the combinations of elements and functions as well as changes in design may be made without departing from the spirit and scope of the invention as hereinafter claimed. These and other modifications to and variations upon the embodiments described above are provided for by the present invention, the scope of which is limited only by the following claims.

CLAIMS

1. A fiber-optic sign (100) comprising:

a housing (102);

a light control circuit (104) for providing light when it is darker than a predetermined threshold;

a plurality of optic fibers (106) with their first ends next to said light control circuit for transmitting the light from said light control circuit;

a display panel (112, 500, 902, 904) of a plurality of apertures (114, 602, 604, 702); and

a plurality of fiber-optic couplers (108, 708) for coupling second ends of said plurality of optic fibers to said display panel, each of said plurality of fiber-optic couplers including

a convex head (302) for uniformly rendering light from each of said plurality of optic fibers,

a body (304) for providing a frictional engagement of said each coupler and said each aperture and resiliently holding said each optic fiber in position, said body having at least one first longitudinal slot (312) and a longitudinal hole (310).

2. A fiber-optic sign as recited in Claim 1 wherein said couplers are made of transparent plastic materials.

3. A fiber-optic sign as recited in Claim 2 wherein said transparent plastic materials include acrylic materials.

4. A fiber-optic sign as recited in Claim 3 wherein a diffusion material is mixed with said acrylic materials to improve optic property of said convex head.

5. A fiber-optic sign as recited in Claim 4 wherein said diffusion material includes dye material.

6. A fiber-optic sign as recited in Claim 1 wherein said body is cylindrical in shape.

7. A fiber-optic sign as recited in Claim 1 wherein said body further has a first neck (306) formed next to said convex head for providing a frictional engagement of said each coupler and said each aperture.

8. A fiber-optic sign as recited in Claim 7 wherein said body is tapered in shape so as to form a stopper (318) between said first neck and said body.

9. A fiber-optic sign as recited in Claim 8 wherein said body further has a second longitudinal slot (314), said first and second longitudinal slots extending through said body and at least part of said first neck and meeting at a right angle, said longitudinal hole running through said body and said first neck for accommodating said each optic fiber.

10. A fiber-optic sign as recited in Claim 9 wherein said body further has a second neck (308) formed between said first neck and said convex head, and said longitudinal hole running through said body, said first neck, and said second neck with said first and second slots extending through said body and first neck.

11. A fiber-optic sign as recited in Claim 10 wherein each of said plurality of apertures has an aperture neck (704) and an aperture body (706), said aperture neck frictionally engaging to said first neck and said aperture body accommodating said stopper and said body.

12. A fiber-optic sign as recited in Claim 11 wherein said convex head is larger than said first neck in diameter, and said first neck larger than said second neck in diameter.

13. A fiber-optic sign as recited in Claim 12 wherein said first neck has a length substantially same as or shorter than that of said second neck.

14. A fiber-optic sign as recited in Claim 1 wherein said longitudinal hole has a tapered shape of a first end and a second end, said first end contacting with said convex head and being larger than said second end in diameter.

15. A fiber-optic sign as recited in Claim 12 wherein said first end is the same as or slightly larger than said each optic fiber in diameter and said second end is slightly smaller than said each optic fiber in diameter.

16. A fiber-optic sign as recited in Claim 1 wherein said display panel is made from plastic by plastic molding process.

17. A fiber-optic sign as recited in Claim 16 wherein said display panel has at least a first side (514, 516) of a location projection (522, 524) and at least a second side (518, 520) of a location cavity (526, 528), said first side having a pair of flanges (714) extending outwardly from said display panel to define a channel (712), and said second side projecting from said display panel so that said channel can receive and locate said second side.

18. A fiber-optic sign as recited in Claim 17 wherein said plurality of apertures are covered by a plurality of masks (606) that may be removed with said couplers being inserted into said apertures.

19. A fiber-optic sign as recited in Claim 1 wherein said display panel is made from metal materials.

20. A fiber-optic sign as recited in Claim 19 wherein said metal materials include aluminum.

21. A fiber-optic sign as recited in Claim 1 wherein a gap between said each aperture is ranged from 0.2-1.5 inch.

22. A fiber-optic sign as recited in Claim 1 wherein a paint is applied to said display panel for defining a pattern to be displayed.

23. A fiber-optic sign as recited in Claim 22 wherein said paint includes vinyl, silkscreen, and enamel.

24. A fiber-optic sign as recited in Claim 1 wherein said light control circuit is located in said housing.

25. A fiber-optic sign as recited in Claim 1 wherein said light control circuit is located outside of said housing.

26. A fiber-optic sign as recited in Claim 1 wherein an angle relative to the surface of the display panel is defined within a range from 0°-15°.

27. A fiber-optic sign as recited in Claim 1 wherein said light control circuit includes at least one light-emitting diode (136, 924).

28. A fiber-optic sign as recited in Claim 27 further comprising a rechargeable battery (134, 922) for supplying power to said light-emitting diode.

29. A fiber-optic sign as recited in Claim 28 wherein said rechargeable battery includes a nickel-cadmium battery.

30. A fiber-optic sign as recited in Claim 28 further comprising means (201, 810, 910) for detecting light and activating said light emitting diode when said light is lower than a threshold.

31. A fiber-optic sign (100) comprising:

a housing (102);

at least one light-emitting diode (136, 924) for providing light;

a rechargeable battery (134, 922) for supplying power to said light-emitting diode;

means (201, 810, 910) for detecting light and activating said light-emitting diode when the light is lower than a threshold;

a plurality of optic fibers (106) with their first ends next to said light-emitting diode for transmitting the light from said light-emitting diode;

a display panel (112, 500) of a plurality of apertures (114, 602, 604, 702); and

a plurality of fiber-optic couplers (108, 708) for coupling second ends of said plurality of optic fibers to said display panel, each of said plurality of fiber-optic couplers including

a convex head (302) for uniformly rendering light from each of said plurality of optic fibers,

a body (304) for resiliently holding said each optic fiber in position, said body having a first longitudinal slot (312), a second longitudinal slot (314), and a longitudinal hole (310), and

a first neck (306) for providing a frictional engagement of said each coupler and said each aperture, said first and second longitudinal slots extending through said body and at least part of said first neck and meeting at a right angle, said longitudinal hole running through said body and said first neck for accommodating said each optic fiber.

32. A fiber-optic sign as recited in Claim 31 wherein said couplers are made of transparent plastic materials.

33. A fiber-optic sign as recited in Claim 32 wherein said transparent plastic materials include acrylic materials.

34. A fiber-optic sign as recited in Claim 33 wherein a diffusion material is mixed with said acrylic materials to improve optic property of said convex head.

35. A fiber-optic sign as recited in Claim 34 wherein said diffusion material includes dye material.

36. A fiber-optic sign as recited in Claim 31 wherein said body is cylindrical in shape.

37. A fiber-optic sign as recited in Claim 31 wherein said body is tapered in shape so as to form a stopper (318) between said first neck and said body.

38. A fiber-optic sign as recited in Claim 37 wherein said each coupler further has a second neck (308) formed between said first neck and said convex head, and said longitudinal hole running through said body, said first neck, and said second neck with said first and second slots extending through said body and first neck.

39. A fiber-optic sign as recited in Claim 38 wherein said first neck is substantially same as said each aperture in diameter.

40. A fiber-optic sign as recited in Claim 38 wherein said convex head is larger than said first neck in diameter, and said first neck larger than said second neck in diameter.

41. A fiber-optic sign as recited in Claim 40 wherein said first neck has a length substantially same as that of said second neck.

42. A fiber-optic sign as recited in Claim 31 wherein said longitudinal hole has tapered shape of a first end and a second end, said first end contacting with said convex head and being larger than said second end in diameter.

43. A fiber-optic sign as recited in Claim 42 wherein said first end is slightly larger than said each optic fiber in diameter and said second end is slightly smaller than said each optic fiber in diameter.

44. A fiber-optic sign as recited in Claim 43 wherein said display panel has at least a first side (514, 516) of a location projection (522, 524) and at least a second side (518, 520) of a location cavity (526, 528), said first side having a pair of flanges (714) extending outwardly from said display panel to define a channel (712), and said second side projecting from said display panel so that said channel can receive and locate said second side.

45. A fiber-optic sign as recited in Claim 31 wherein said plurality of apertures are covered by a plurality of masks (606) that may be removed with said couplers being inserted into said apertures.

46. A fiber-optic sign as recited in Claim 31 wherein a gap between said each aperture is ranged from 0.2-1.5 inch.

47. A fiber-optic sign as recited in Claim 31 wherein a paint is applied to said display panel for defining a pattern to be displayed.

48. A fiber-optic sign as recited in Claim 46 wherein said paint includes vinyl, silkscreen, and enamel.

49. A fiber-optic sign as recited in Claim 31 wherein an angle relative to the surface of the display panel is defined within a range from 0°-15°.

50. A fiber-optic sign as recited in Claim 49 wherein said rechargeable battery includes a nickel-cadmium battery.

51. A fiber-optic sign as recited in Claim 31 wherein said light-emitting diode is located inside of said housing.

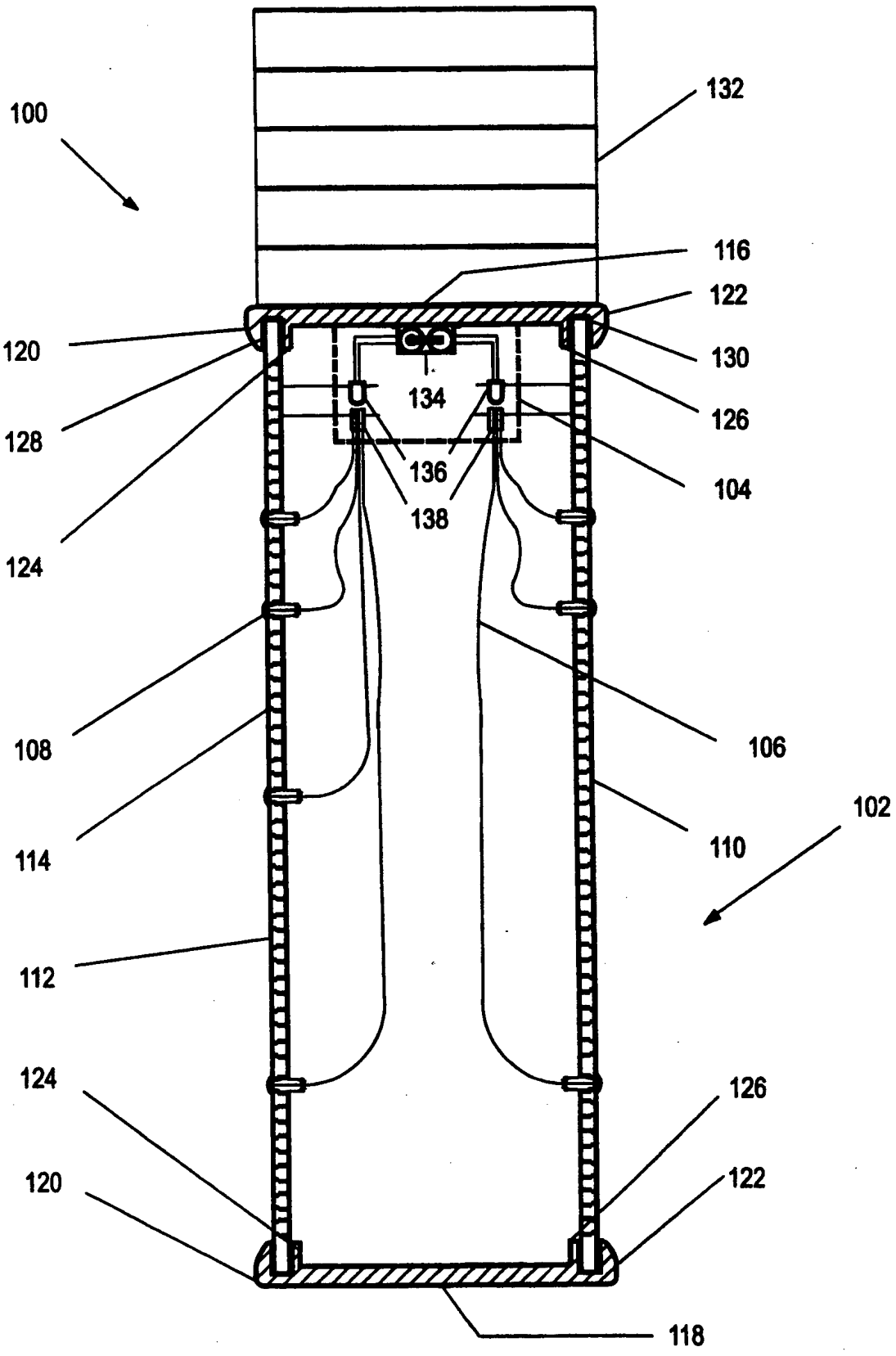
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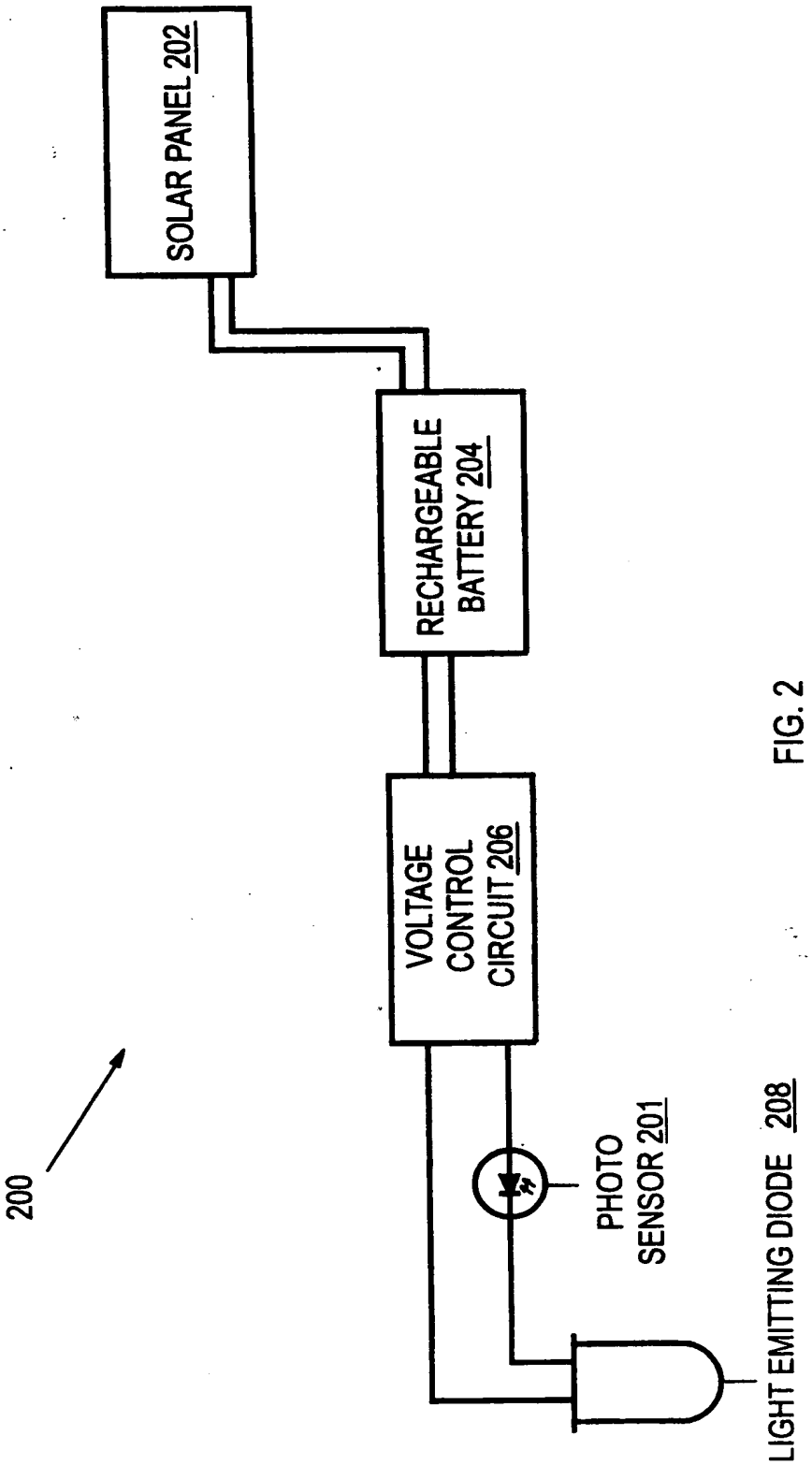
FIG. 1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RECHARGEABLE BATTERY 204
VOLTAGE CONTROL CIRCUIT 206
PHOTO SENSOR 201
LIGHT EMITTING DIODE 208
200

FIG. 2

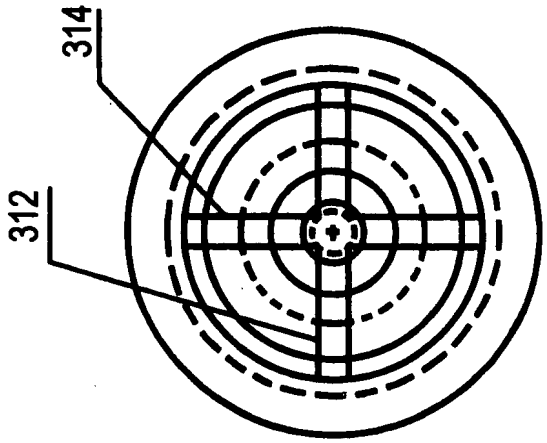

FIG. 4

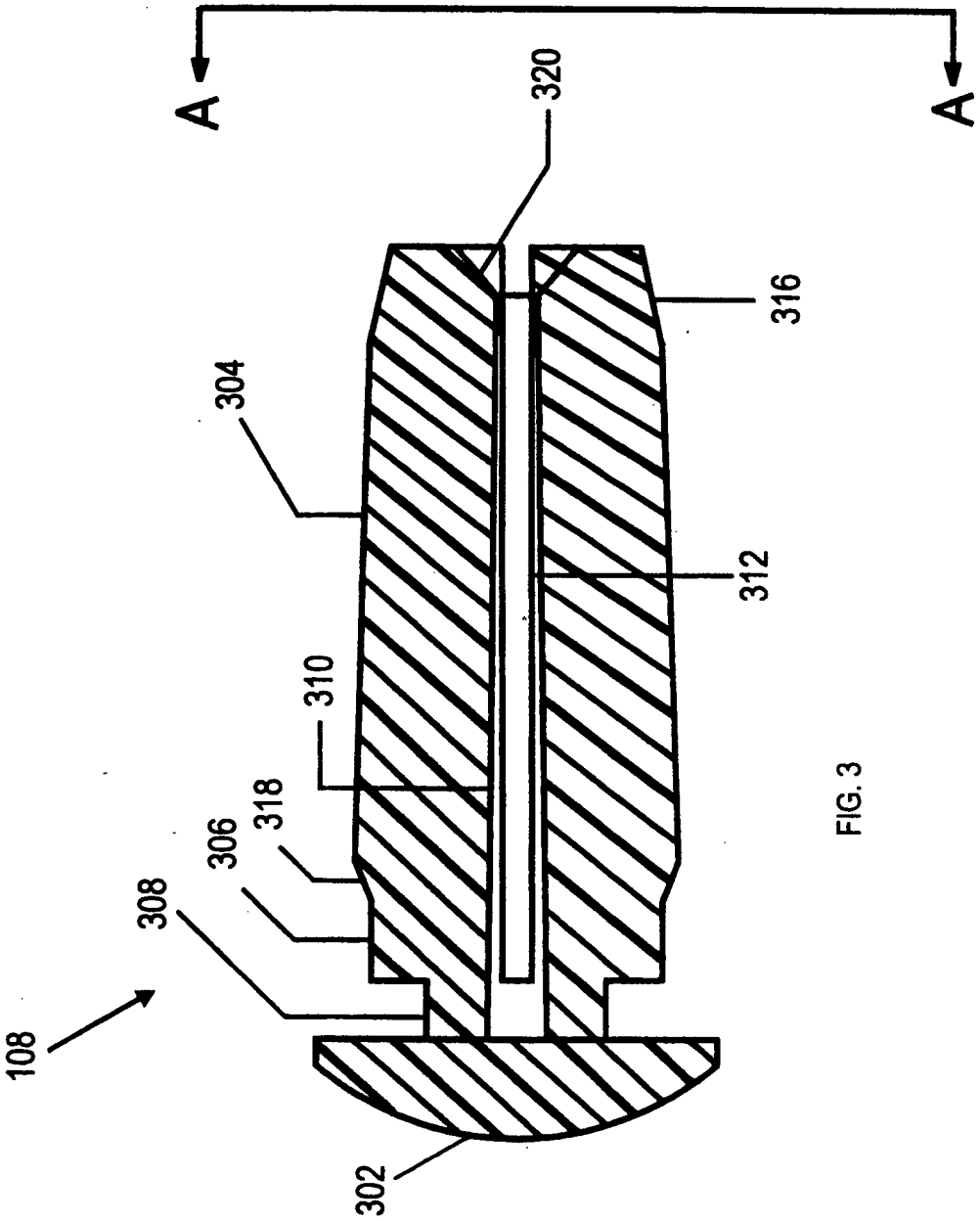

FIG. 3

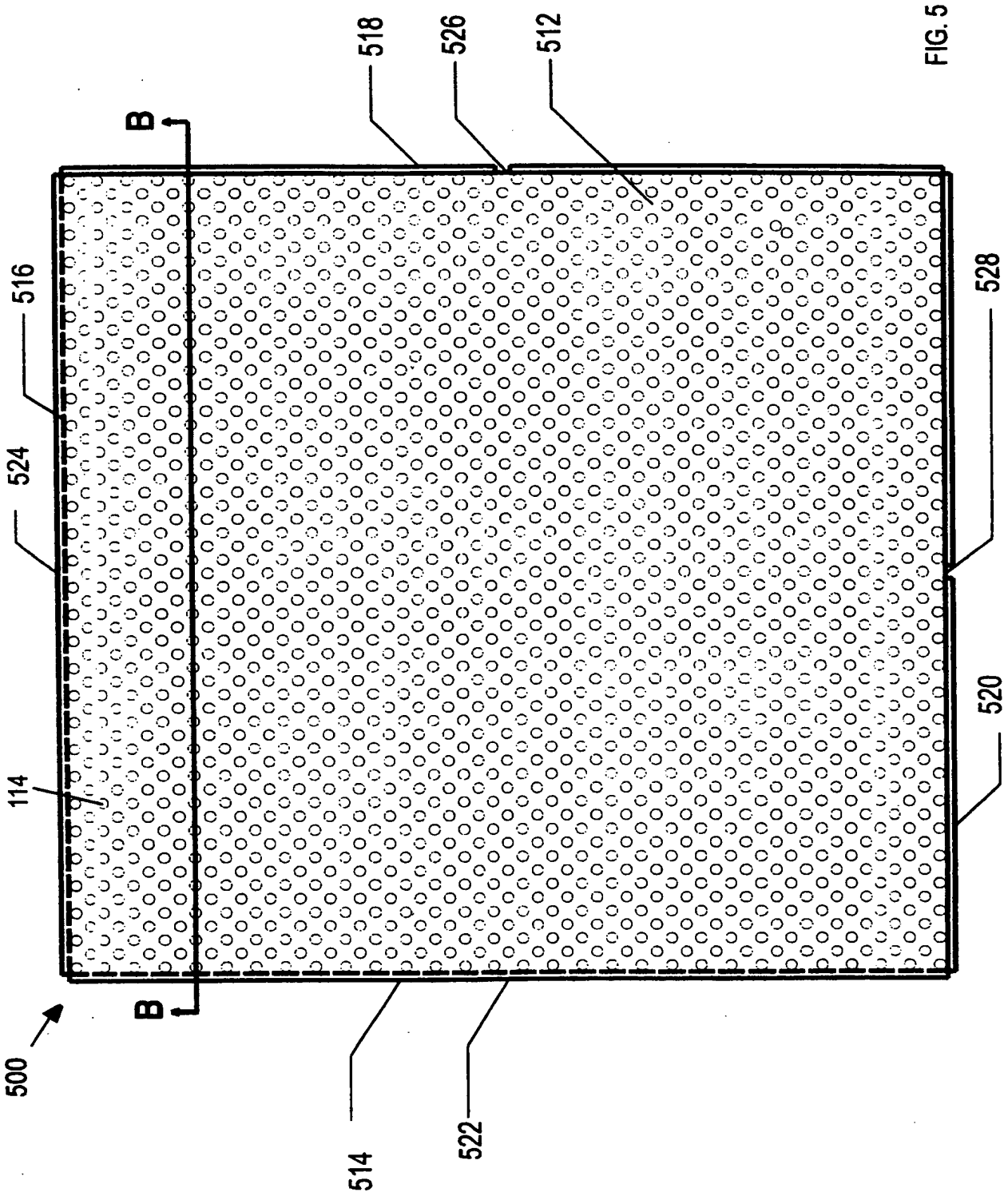

FIG. 5

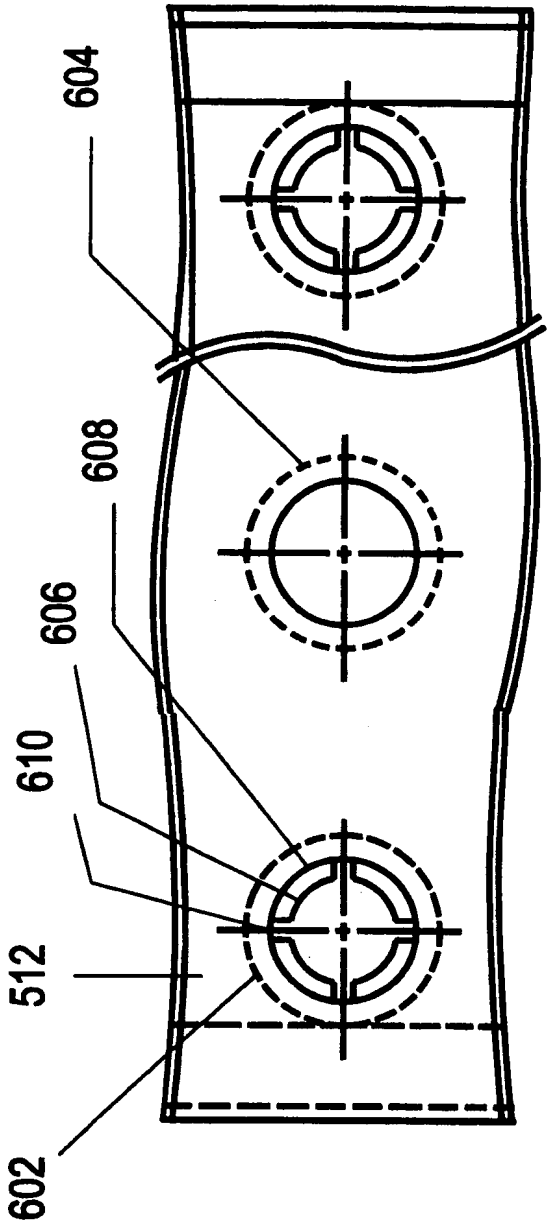

FIG. 6

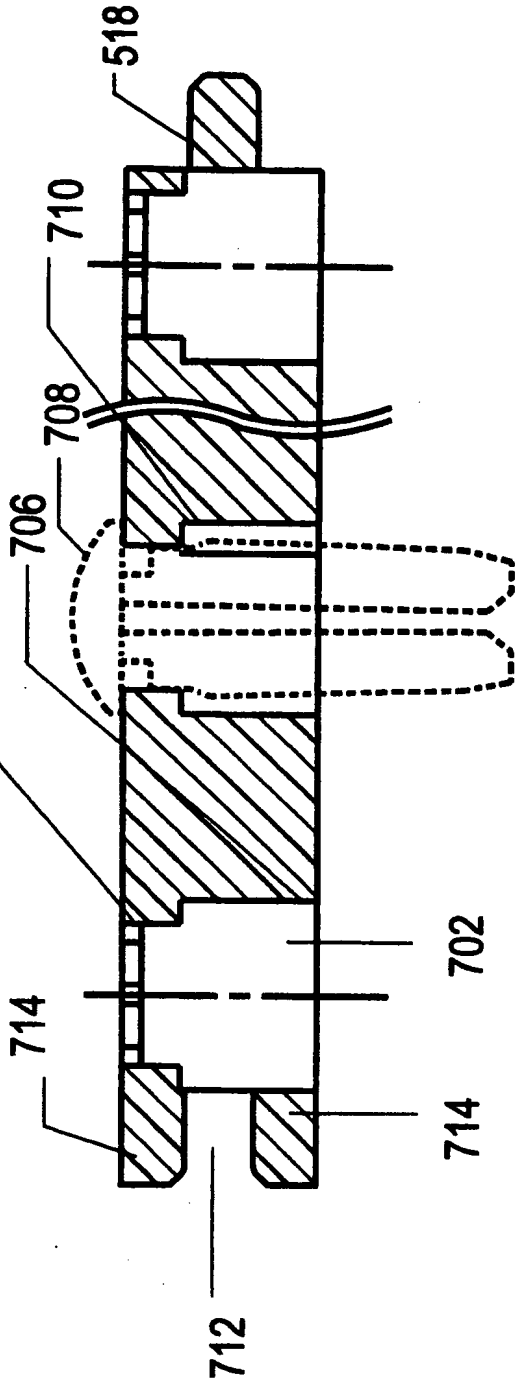

FIG. 7

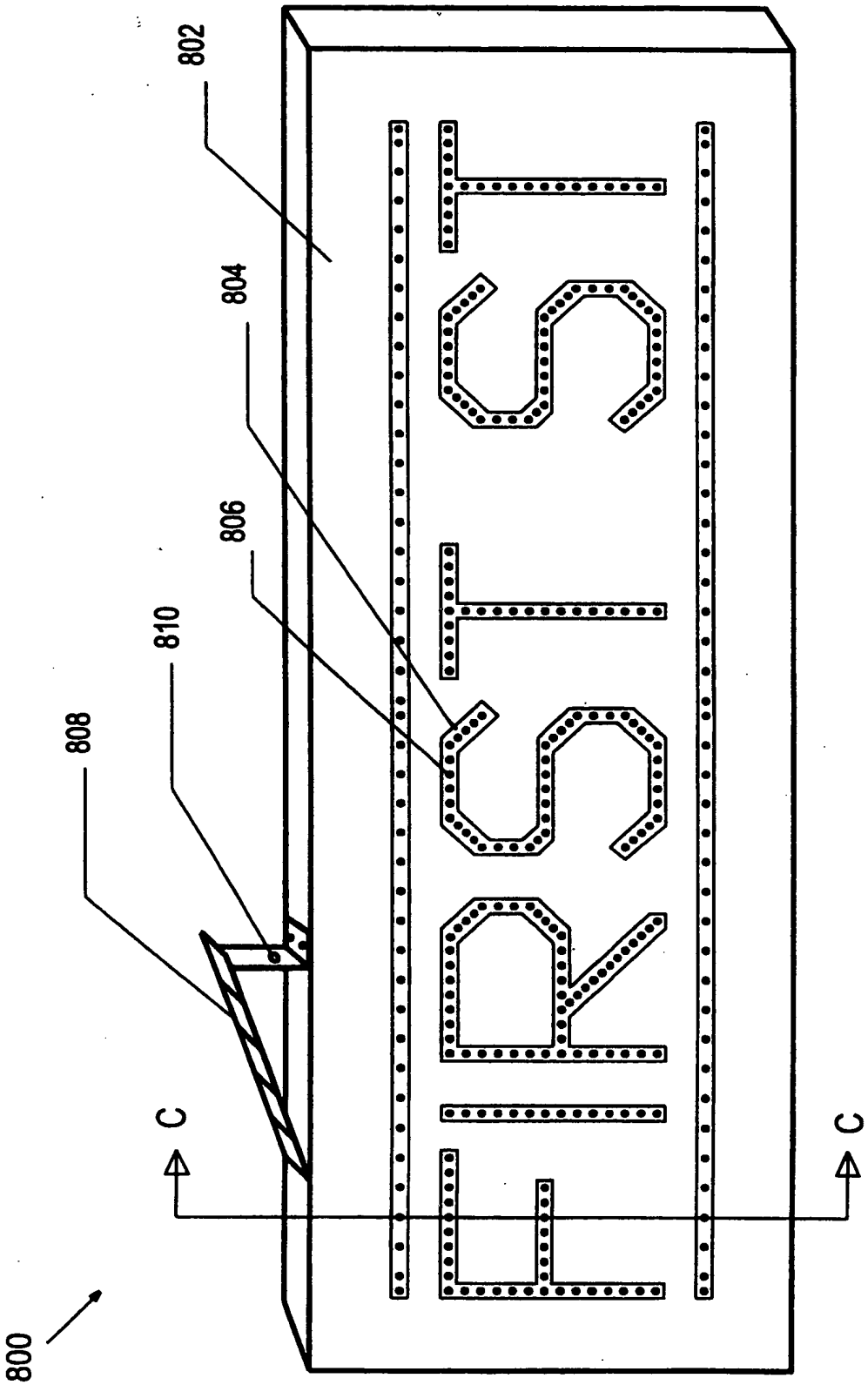

FIG.8

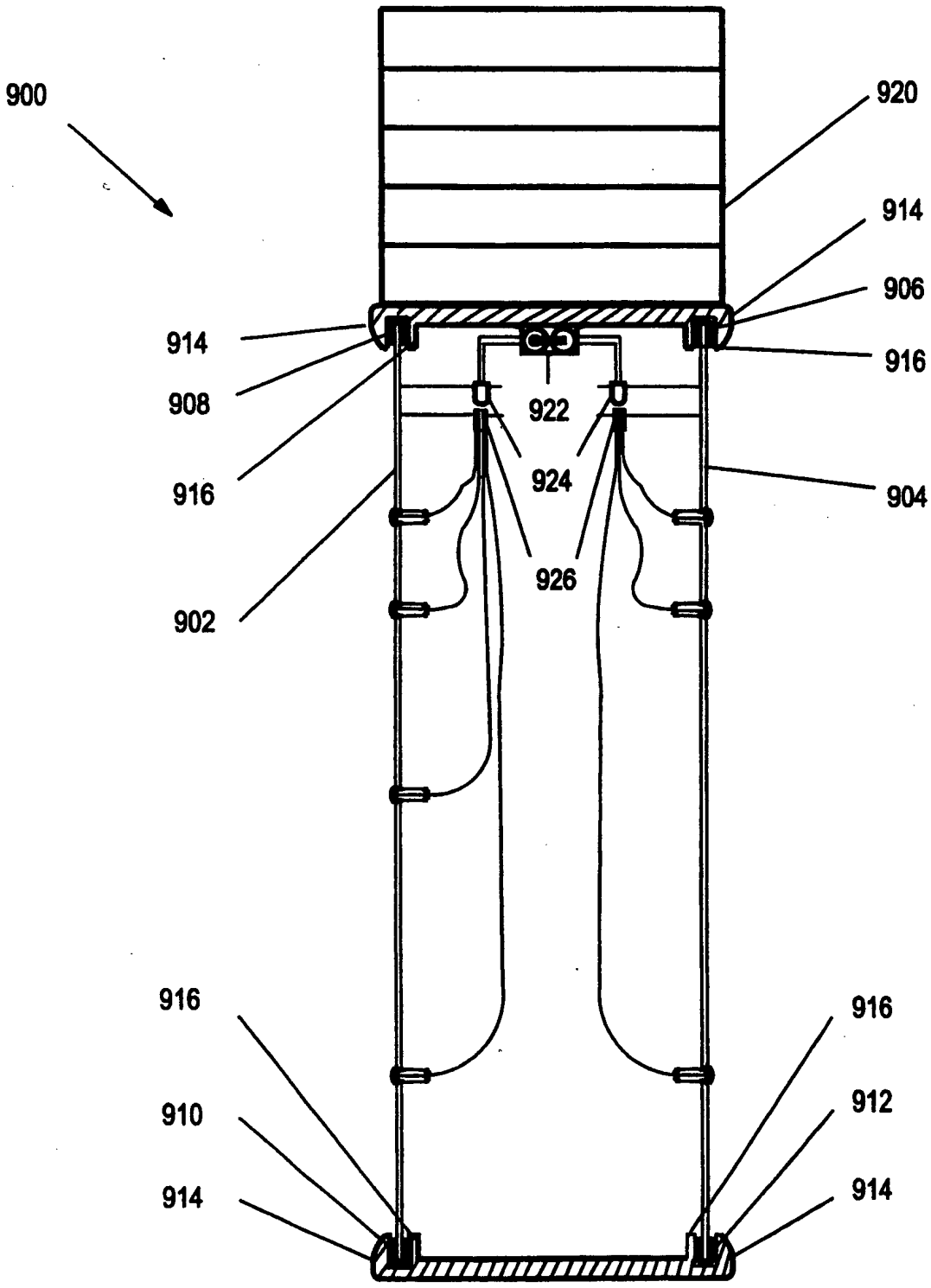
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FIG. 9

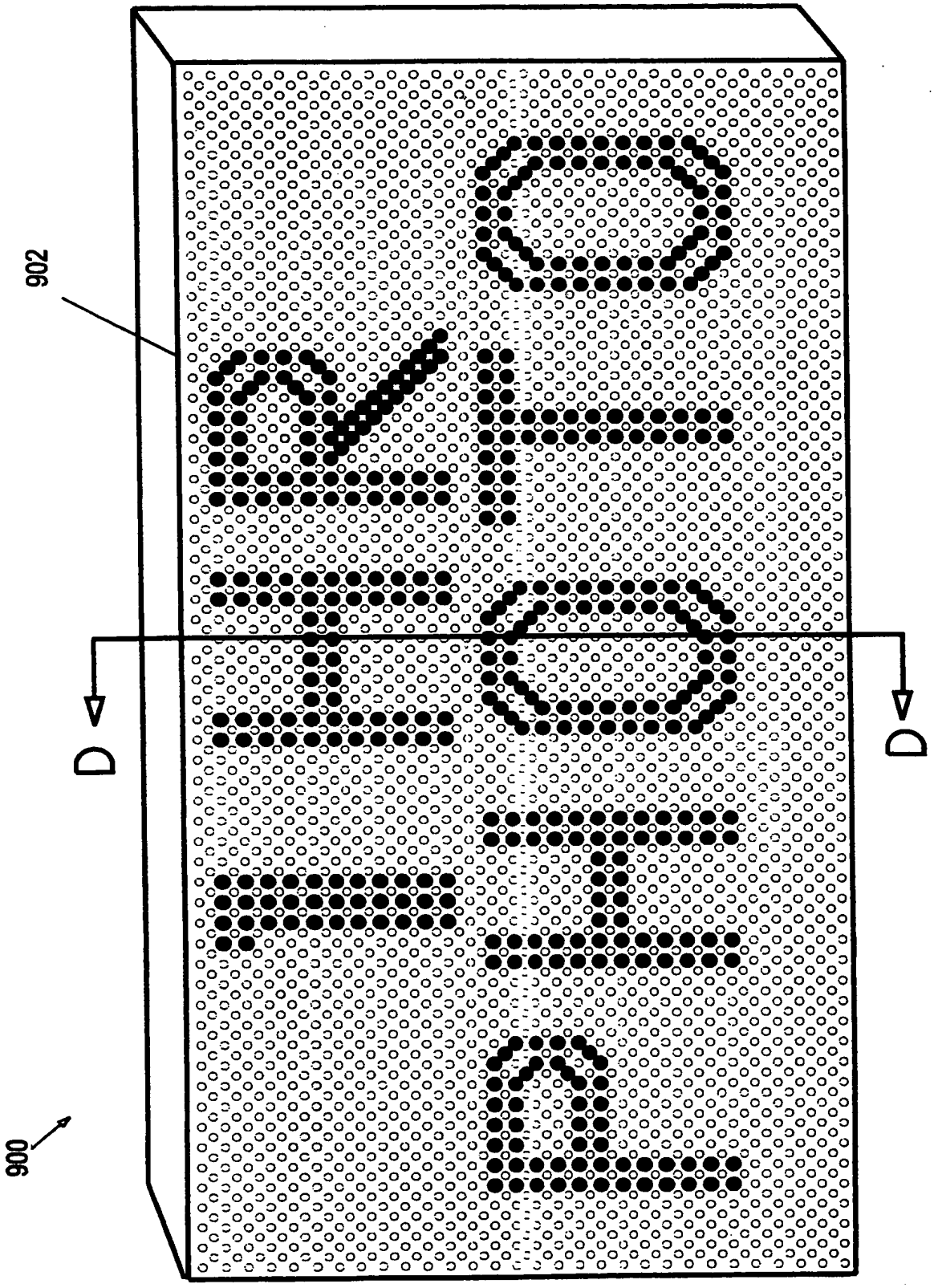

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/02592

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G09F 13/00
US CL :40/547,550; 362/32,812
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 40/547,550,564; 362/32,812

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,917,448 A (Oppenheimer) 17 April 1990 (17.04.90), see figures 4 and 6.	1-8,14,16, and 19-30
Y	US 4,814,948 A (Hasegawa) 21 March 1989 (21.03.89), see figure 1.	1-8,14,16, and 19-30
Y	US 4,848,017 A (Bailey et al.) 18 July 1989 (18.07.89), see figure 1.	1-8,14,16, and 19-30
Y	US 5,303,124 A (Wrobel) 12 April 1994 (12.04.94), see figure 6.	28-30

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 MARCH 1997	14 MAY 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer BRIAN K. GREEN Telephone No. (703) 308-2168

Form PCT/ISA/210 (second sheet)(July 1992)*

Patents Act 1977
Examiner's report to the Co[redacted]oller under Section 17
(The Search report)

Application number
[redacted] 9316222.0

Relevant Technical Fields

(i) UK Cl (Ed.M) G5C (CEJ, CEK, CEPL)

(ii) Int Cl (Ed.5) G09F

Search Examiner
R A H CASLING

Date of completion of Search
9 SEPTEMBER 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-16

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 758915	(ETZKORN) see page 2 lines 5-23 and page 3 lines 17-24	1, 12 at least
X	GB 620691	(HIRSCHHORN) see page 1 line 56 et seq	1, 12 at least
X	GB 554849	(ELECTRONIC LABORATORIES) see page 1 line 88 et seq	1, 10, 12, 13 at least
X	GB 459683	(BRITISH CELANESE) see page 3 line 21 et seq	1, 12 at least
X	US 4703574	(GARJIAN) see 4 line 47 et seq	1, 10, 12 at least
X	US 4172631	(IZON) see 7 line 30 et seq	1 at least

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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